

Measuring the Quality of Education and Quality-Adjusted Human Capital at Industry-Level: Evidence from the European Union

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Summary

1. This policy brief summarises recent research introducing a novel measure of human capital at the industry level that incorporates both the quantity and quality of education for 19 one-digit NACE industries across 21 EU countries and the UK between 2010-2021.
2. The measure is constructed by combining student and adult test scores as a measure of quality of education and mean years of schooling as a proxy of the quantity of education. Additionally, it uses the age composition in employment to link country-level education outcomes with industry-level employment structure.
3. Validation tests suggest that the contribution of this new quality-adjusted human capital to industry output is consistent with previous macroeconomic estimates of output elasticities of human capital.
4. Moreover, the quality-adjusted human capital measure has a stronger association with labour productivity growth at the industry level compared to measures of human capital such as the share of employees with medium or high education attainment and other alternative quantitative measures of human capital.

1. Introduction

The term *human capital* intends to account for all the productive capacities of human beings as income generating agents in the economy (Rosen, 2008). This concept gained relevance

in the late 1980s when foundational works by Lucas (1988), Romer (1990), and Mankiw et al. (1992) established investment in human capital as a key driver of long-run growth alongside innovation.

A central issue relating to human capital is how to measure its stock since it involves a

general skill level (Lucas, 1988) that is not directly observable. Pioneering empirical work, such as Mankiw et al. (1992), proxied it with the mean years of schooling in each country. However, empirical measures relying on the mean years of schooling have struggled to explain macroeconomic outcomes such as productivity growth in a satisfactory manner, a challenge that has been referred to as the *human capital paradox* (Botev et al., 2020).

Recent studies overcame this challenge by adding proxies for the quality of education such as standardised student test scores. A further issue relates to how to aggregate both components, with most studies using either the product or imposed weights to obtain an overall measure (Fournier & Johansson, 2016; Angrist et al., 2020). In that sense, recent work by Égert et al. (2022) addresses these limitations by empirically estimating the relative contributions of each component in explaining country differences in adult test scores that are matched to the relevant historical student-level assessments.

Despite these developments at the macro (country) level, the literature has so far focused on the quantity of education at the industry level. This policy brief summarises a research paper by Duran, Jordan, and Siedschlag (2025), part of the EFFEct project which aims to fill this evidence gap. This research puts forward a novel measure of human capital at the industry level that incorporates both the quantity and quality of education for 19 one-digit NACE industries across 21 EU countries and the UK between 2010-2021. Measuring human capital by industry is important since industries differ significantly in their skill requirements. Moreover, differences in human capital composition across industries can help

explain cross-country productivity gaps and other structural patterns.

2. Data and Methods

This research employs student test scores data from the OECD's Programme for International Student Assessment (PISA), adult test scores from the Programme for the International Assessment of Adult Competencies (PIAAC) (OECD, 2023; 2024), and mean years of schooling from the Wittgenstein Centre (Wittgenstein Centre for Demography and Global Human Capital, 2018). Following Égert et al. (2022), adult test scores are matched with student test scores and mean years of schooling by cohort. For example, a 25-year-old Irish PIAAC respondent in 2011 is matched to Ireland's PISA score from 2001 (when they were 15) and the corresponding mean years of schooling in Ireland for that cohort in 2001, applying one- or two-year lags when needed. Using these data, this study estimates the empirical weights of the quality (student test scores) and quantity (mean years of schooling), allowing for a weaker link for older cohorts as in Égert et al. (2022).

The quality-adjusted human capital measure is then constructed using the estimated elasticities as weights and EU KLEMS & INTANProd data (Bontadini et al., 2023) on labour composition of workers with formal qualifications by age cohort for each industry and re-scaling the resulting measure to the mean years of schooling range for ease of interpretation.

Similar to Égert et al. (2022), the estimated weight of the quality component in this new measure is roughly three times the one of the quantity component. Patterns across industries are similar when comparing the

new measure with the employment share of workers with intermediate or higher educational attainment, while there are larger differences when contrasting it to the employment share of workers with high education (see Figure 1). In particular, electricity and gas supply (D), real estate activities (L), and health and social work (Q), rank higher relative to information and communication (J), financial and insurance activities (K), and professional, scientific and technical activities (M).

3. Validation

To determine the link of our measure with industry-level productivity growth, this research uses two complementary approaches. First, it uses a Stochastic Frontier model to estimate the contribution of human capital to the industry's production. The result reveals that including the new measure yields output elasticities with respect to human capital that are in line with prior macroeconomic literature (0.36 to 0.44). Second, it examines the drivers of labour productivity (value-added per worker) growth. While most human capital proxies display positive but statistically insignificant effects, the new measure exhibits a significant positive association with productivity growth.

4. Policy Recommendations

Education is a major driver of productivity growth and an important component of economic policy. Industrial and education policies increasingly target specific sectors given macro-trends such as the green and digital transitions. Training, upskilling, and reskilling are important parts of the Industrial Strategy for Europe adopted in 2021.

The results of this research indicate that improving the quality of education is linked to greater productivity gains in the long-run than increasing the quantity of education measured as mean years of schooling. A number of policy recommendations emerge from the evidence provided by this research.

At school levels, policy measures should focus on enhancing the quality of education and improving the ability of students to score highly on the core subjects.

At firm and industry levels, investment in training, upskilling and reskilling could enable the workforce to prepare to face the challenges from rapid technological change and digital transformation.

Measuring the quality and quantity of human capital at industry-level provide policymakers with the granularity needed to assess whether industries have the human capital necessary to face these macro-trends and whether public investments in education and training align with industry needs.

At Member States level, measuring the quality of education and introducing measures of quality of education in frameworks for the evaluation of the economic effects of education policies on productivity gains could contribute to enhancing the efficiency and effectiveness of investment in education.

At the EU level, monitoring and benchmarking the quality of education in Member States could provide useful lessons from best practices.

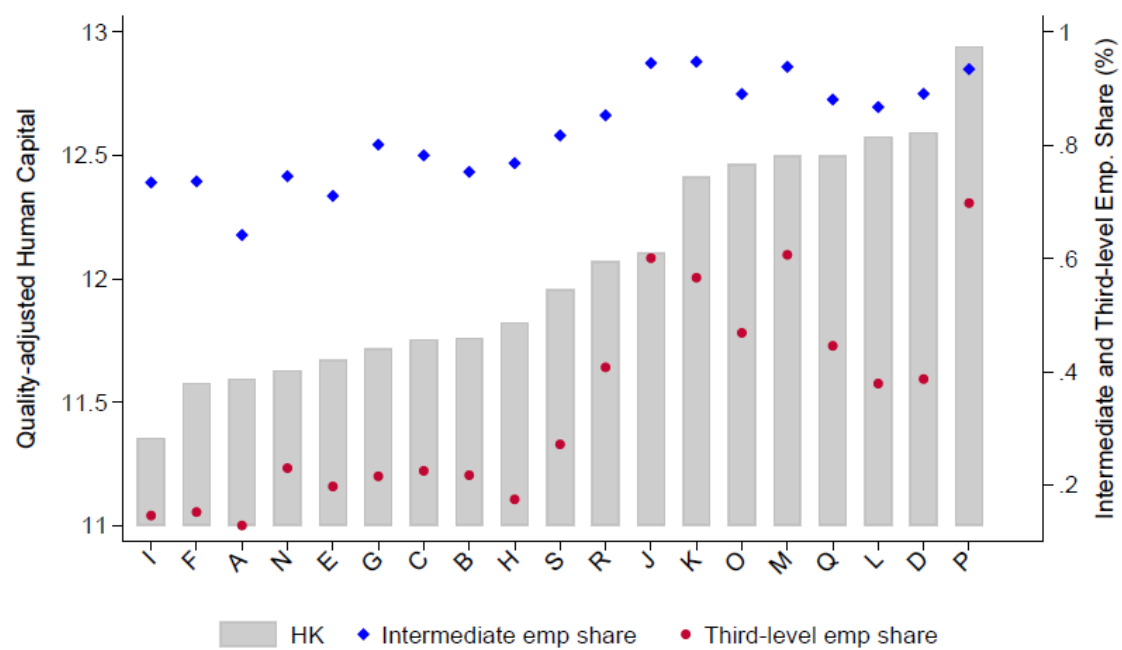
What is EFfEct ?

EFfEct is an impact-driven research project aiming to enhance the quality of education in the EU by providing evidence-based policy recommendations and conducting rigorous research on the education policies of individual EU member states.

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Figures



Further Information:

Duran Vanegas, J., Jordan, M., and Siedschlag, I. (2025). An Industry-Level Measure of Quality-Adjusted Human Capital in the European Union, ESRI Working Paper 812, Dublin: ESRI, <https://www.esri.ie/publications/an-industry-level-measure-of-quality-adjusted-human-capital-in-the-european-union>



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